S6-90

Dust Evolution from Comets and Asteroids: Their Velocites at Earth Orbit Intersection

A. A. Jackson, Lockheed Engineering and Science Co., Houston, Texas
H. A. Zook, NASA Johnson Spacecraft Center, Houston, Texas

We have revised and updated the study published by Jackson and Zook in Icarus [1] on the evolution of dust particles from comets and asteroids. In our previous study the planets only moved in simple two-body orbits. In the study we report here, the effects of accurate many-body planetary motion on the gravitational perturbations of the dust grains are computed.

In a computer simulation, dust grains of radius 10, 30, and 100 μm were released at perihelion passage from each of 36 different celestial bodies: 16 main belt asteroids, 15 short period comets with perihelion greater than 1 AU, and 5 short period comets with perihelion less than 1 AU. (There has been one asteroid added to the model since the last study.) The evolving orbit of each of the 108 released dust grains was then continuously computed with the Everhart numerical integrator until the dust particle orbital aphelion passed inside of 0.387 AU, or the dust grain had been ejected from the solar system. The forces due to the gravitational fields of the Sun and the planets as well as radiation pressure, Poynting-Robertson drag, and solar wind drag were all included in these numerical simulations.

Table I displays the orbital elements when the dust crosses the Earth's orbit at a node. When compared to the same table in our Icarus paper we note there is little change in the evolved orbital characteristics. The only slight exception being that the magnitude of the intercept speed at the Earth's orbit for 10 micron particles is about one km/sec higher. This gives us confidence that the original simplified analysis we simulated is accurate.

It is found that when dust grains evolve to intersection with the Earth's orbit, they nearly always retain orbital characteristics indicative of their origins; grains from main belt asteroids differ significantly in orbital characteristics, especially in orbital eccentricity, from grains that evolve from comets. In reference 1 we plotted eccentricity versus orbital crossing speed as method of separating asteroids from comets. We present a new method that examines velocity components versus the magnitude of velocity. These velocity components are the radial, tangential and normal ones of the grain velocity in a coordinate frame fixed to the earth.

In figure 1 we plot the radial velocity versus the magnitude of the velocity. We see a very marked separation in the velocity magnitude between the asteroidal and cometary particles. The higher eccentricities and inclinations of the cometary particles preserve their position in the higher velocity regions on this plot. The asteroidal particle that is in the approximate 12 km/sec velocity region is from asteroid Hungaria which has an inclination of 22.5 degrees so that this particle's crossing speed has a higher normal-to-the-plane component. In fig. 1 even the lowest velocity components are almost a factor of 2 greater than the velocity of the great majority of asteroidal particles. It appears that a velocity sensor in earth orbit should genearally be able to distinguish between the dust grains from asteroids and comets.

We will address the issue of using these velocity data to specify what accuracy a velocity measurement must meet in order to distinguish between asteroidal and cometary particles captured by an instrument in earth orbit.

[1] Jackson, A. A. and Zook, H.A. (1992). Orbital Evolution of Dust Particles from Comets and Asteroids, Icarus, 97, 70-84.

Table I Summary of particle orbital elements and velocites as they cross at the ascending node and descending node of their orbits at the Earth's orbit. <e> is the average eccentritity, σ is its standard deviation, e is its minimum, and e is its maximum. Simililarly for the inclination, i, and the magnitude of the relative velocity ,u, at crossing.

	Asteroids			Comets(q>1 AU)			Comets(q<1 AU)		
	10μ	30μ	100μ	10μ	30μ	100μ	10μ	30μ	100μ
<e>	.091	.157	.128	.509	.405	.407	.583	.580	.583
σ	.042	.077	.056	.218	.200	.175	.088	.115	.131
e_{min}	.005	.003	.043	.110	.075	.125	.131	.305	.255
e_{max}	.198	.328	.282	.854	.998	.999	.998	.926	.998
<i> (deg)	9.12	8.95	11.53	16.4	12.29	16.3	14.50	21.7	14.5
σ	5.593	5.94	3.78	6.62	4.38	9.24	8.1	12.9	8.13
i_{min}	.451	1.59	.659	.1.28	2.65	6.32	3.72	1.37	3.72
i_{max}	23.2	21.0	18.4	37.5	32.77	107.2	54.4	63.4	54.4
<u> (km/sec)	5.38	6.50	6.84	14.3	10.67	11.9	13.94	16.4	13.9
σ	2.81	2.71	1.60	3.21	3.22	5.28	4.90	6.12	4.90
u_{min}	0.41	2.06	2.75	9.79	4.77	7.04	9.33	11.6	9.3
u_{max}	12.53	13.91	10.6	29.8	21.76	58.3	33.0	36.4	33.0

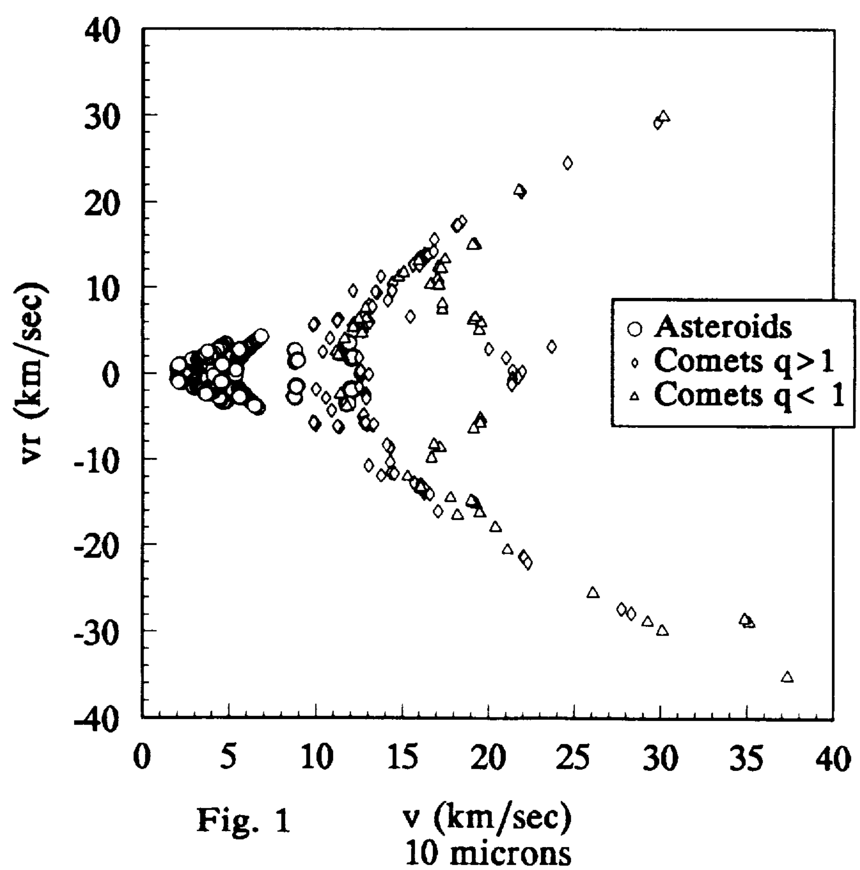

Fig. 1